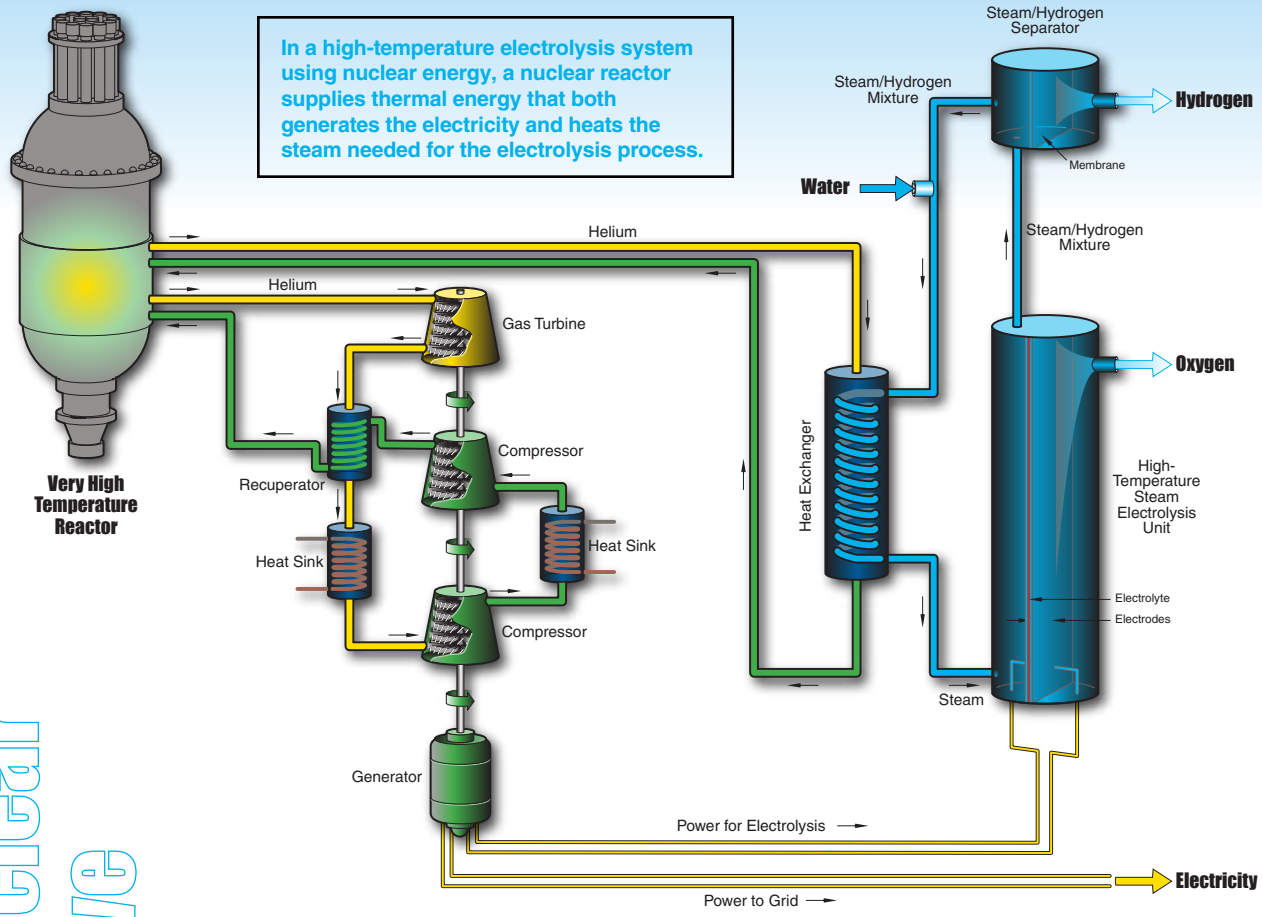

Advancing the Nuclear Hydrogen Initiative

High-Temperature Electrolysis

Unlocking Hydrogen's Potential with Nuclear Energy

Efficient production of hydrogen without increased greenhouse gas emissions is the key to achieving the "hydrogen economy" envisioned by the Nuclear Hydrogen Initiative. As the lead laboratory for the Department of Energy's Office of Nuclear Energy, the Idaho National Laboratory is assuming a major role in developing technologies to produce hydrogen using nuclear energy. One of the most promising of these technologies is called high-temperature electrolysis.

What Is High-Temperature Electrolysis?

One way to produce hydrogen is electrolysis – using electricity to separate hydrogen from water. By performing electrolysis at high temperatures, its overall efficiency increases considerably. In a high-temperature electrolysis system using nuclear energy, a nuclear reactor supplies thermal energy that both generates the electricity and heats the steam needed for the electrolysis process. A high-temperature heat exchanger supplies steam superheated to about 850 degrees Celsius. Heat from the reactor is also used to generate electricity. The combination of electric power and high temperature splits the H_2O molecules into hydrogen and oxygen in a stack of ceramic electrolysis cells.

The Advantages of Nuclear-Powered High-Temperature Electrolysis

Nuclear-powered high-temperature electrolysis is the key to efficient, clean production of hydrogen.

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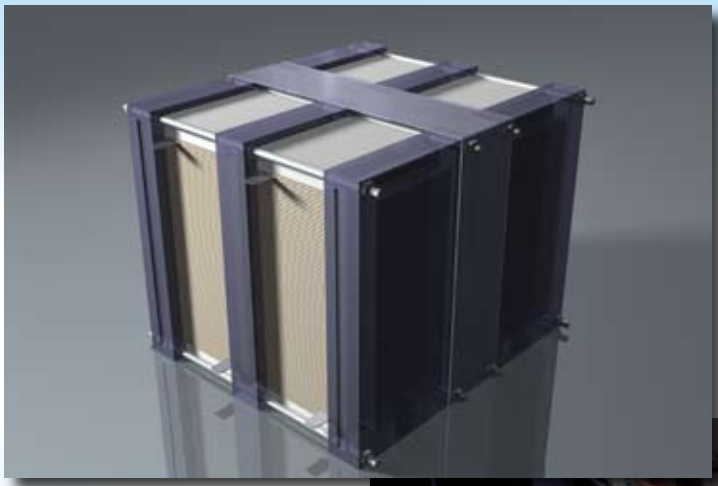
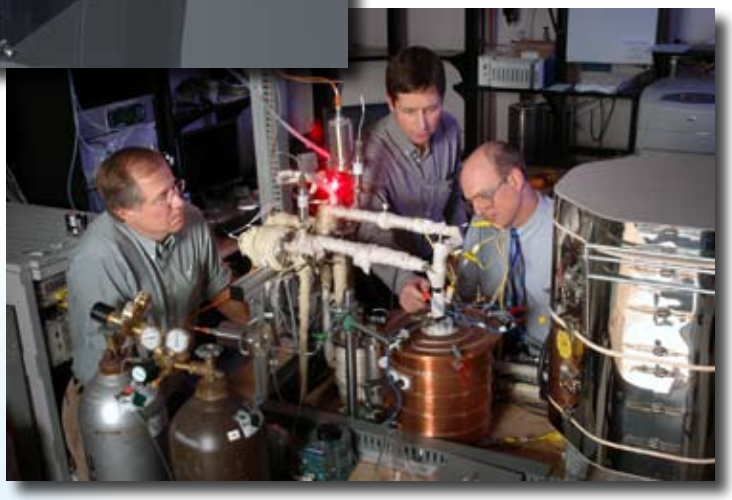


INL is already testing the use of solid-oxide cells – used mainly for power production in fuel cells – for electrolysis.



In fuel cells, hydrogen and oxygen are combined electro-chemically to produce water, and, in the process, heat and electricity. INL is experimenting with reversing the process – using solid-oxide cells to split water into hydrogen and oxygen while consuming electricity and heat.

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- High-temperature systems reduce the amount of electricity needed for hydrogen production, and generate the necessary electricity more efficiently.
- A high-temperature advanced nuclear reactor coupled with a high-efficiency high-temperature electrolyzer would be extremely efficient, with a thermal-to-hydrogen conversion efficiency of 45 to 55 percent.
- Using nuclear energy rather than fossil fuels for electrolysis would allow hydrogen production with no associated greenhouse gas emissions.
- High-temperature electrolysis plants could serve an important balancing function, supplying electricity to the power grid when electricity demand is high or drawing electricity from the grid when demand is low to produce extra hydrogen.

It's Happening at INL

INL is leading research on using nuclear energy for high-temperature electrolysis. INL is already testing the use of solid-oxide cells – used mainly for power production in fuel cells – for electrolysis. In fuel cells, hydrogen and oxygen are combined electro-chemically to produce water, and, in the process, heat and electricity. INL is experimenting with reversing the process – using solid-oxide cells to split water into hydrogen and oxygen while consuming electricity and heat. A new generation of nuclear reactor under development at INL, the Very High Temperature Reactor, will eventually supply both electricity and high-temperature heat to the electrolyzer.

Conceptual design and analysis for hydrogen production facilities is underway at INL.

- The high temperature electrolysis Integrated Laboratory Scale experiment started operation with one module (5 kW) in August 2007 and will operate with three modules in September 2008.
- A pre-conceptual design for a pilot-scale (500 kilowatts) high-temperature electrolysis facility is complete. The Nuclear Hydrogen Initiative's Research and Development Plan calls for the facility to be deployed around 2013.
- The plan calls for a larger 5 megawatt engineering demonstration facility to be developed at INL around 2019.

For More Information

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The INL is one of the U.S. Department of Energy's multiprogram national laboratories, and is managed by Battelle Energy Alliance, LLC.

08-GA50044-06